Environmental assessment and nano-mineralogical characterization of coal, overburden and sediment from Indian coal mining acid drainage

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Abstract

The deterioration of environmental conditions is the major contributory factor to poor health and quality of life that hinders sustainable development in any region. Coal mining is one of the major industries that contribute to the economy of a country but it also impacts the environment. The chemical parameters of the coal, overburden, soil and sediments along with the coal mine drainage (CMD) were investigated in order to understand the overall environmental impact from high sulphur coal mining at northeastern coalfield (India). It was found that the total sulphur content of the coal is noticeably high compared to the overburden (OB) and soil. The volatile matter of the coal is sufficiently high against the high ash content of the soil and overburden. The water samples have a High Electrical Conductivity (EC) and high Total Dissolve Solid (TDS). Lower values of pH, indicate the dissolution of minerals present in the coal as well as other minerals in the mine rejects/overburden. The chemical and nano-mineralogical composition of coal, soil and overburden samples was studied using a High Resolution-Transmission Electron Microscopy (HR-TEM), Energy Dispersive Spectroscopy (EDS), Selected-Area Diffraction (SAED), Field Emission-Scanning Electron Microscopy (FE-SEM)/EDS, X-ray diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Raman and Ion-Chromatographic analysis, and Mössbauer spectroscopy. From different geochemical analysis it has been found that the mine water sample from Ledo colliery has the lowest pH value of 3.30, Tirap colliery samples have the highest electrical conductivity value of 5.40 ms cm−1. Both Ledo and Tirap coals have total sulphur contents within the range 3–3.50%. The coal mine water from Tirap colliery (TW-15B) has high values of Mg^{2+} (450 ppm), and Br^{-} (227.17 ppm). XRD analysis revealed the presence of minerals including quartz and hematite in the coals. Mineral analysis of coal mine overburden (OB) indicates the presence both of pyrite and marcasite which was also confirmed in XRD and Mossbauer spectral analysis. The presented data of the minerals and ultra/nano-particles present shows their ability to control the mobility of hazardous elements, suggesting possible use in environmental management technology, including restoration of the delicate Indian coal mine areas.

Keywords

Coal Mine Drainage, Environmental Assessment, Indian Coal, Chemical Analysis, Nano-Mineralogy, Advance Characterization